METHOD FOR SETTING, IN A MOTOR VEHICLE ELECTRICAL POWER STEERING SYSTEM, THE SET POINT OF THE ASSISTANCE TORQUE

The invention relates to a method for setting, in a motor vehicle electrical power
5   steering system of the type which includes a vehicle steering column and a steering
assistance electric motor, the set point of the torque that must be applied to the steering
column by the assistance motor during power steering with a lower part suitable for acting
on a mechanical steering device, a method according to which the assistance set point is
established from information concerning the torque exerted by the driver on the steering
10   wheel.

The invention also relates to an electrical power steering system for implementation
of this method.

In known electrical power steering systems of this type, the steering wheel torque
exerted by the driver when the vehicle is in motion is measured by a dedicated torque
15   sensor. The information thus obtained is subsequently processed by an on-board computer
in order to determine the set point of the torque that must be applied to the steering column
by the assistance motor, for example, in case of turning.

These electrical power steering systems have the major disadvantage that the torque
sensors have a complex and bulky structure and are difficult to use and calibrate.

20   The objective of the invention is to propose a method for setting the set point which
is to be applied to the steering column of an automobile in a power steering system and a
corresponding steering system which make it possible to remedy the disadvantages of the
prior art just mentioned.

In order to attain this objective, the method according to the invention is
25   characterized by the fact that the information concerning the steering wheel torque is
obtained by measurement of the angles of the steering column, at the site of the steering
wheel and at the site of the assistance motor, and the set point of the torque to be applied by
the assistance motor is established by comparison of the two angle measurements while
taking into account the rigidity of the steering column between the two angle measurement
30   sites.

According to one characteristic of the invention, the angle, speed and acceleration of
the steering wheel and the position, speed and acceleration of the assistance motor acting on
the lower part of the steering column are measured.

According to another characteristic of the invention, an operation for verifying the
35   validity of the acquired measurement values is carried out.

According to yet another characteristic of the invention, the load on the steering

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wheel is computed by comparison of the positions of the two angle sensors; the variation of the steering wheel load is computed with respect to the speeds of rotation between the two sensors; PID type filtering is done on the two measurements made, and the resulting information is used as torque information for computation of the set point of the assistance torque that must be applied to the steering column by the assistance motor.

According to yet another characteristic of the invention, a test is done as to whether recalibration of the assistance function is possible and necessary, and in the case of a negative response, the program for setting the set point of the assistance torque returns to the operation of measuring the magnitudes.

According to yet another characteristic of the invention, in the case of a positive response, a computation of a new compensation with regard to the midpoint position of the steering is done, and if necessary, a recomputation of the value of the play in the reducing gear associated with the motor is done, and the program, after storing this information, is brought to the operation of measuring the magnitudes.

According to yet another characteristic of the invention, the recalibration test is done based on at least the information of the passage of the steering wheel through the zero position, the speed of rotation of the steering wheel and of the motor which must be less than a predetermined threshold, on the determination that there is no degraded mode in progress, and on the possible validation of the data obtained during the operation of measuring the magnitudes.

According to yet another characteristic of the invention, an intermediate part in the form of a torque rod is provided between the upper and lower parts of the steering column, and the rigidity of this rod is taken into account in setting the aforementioned torque set point.

The electrical power steering system for implementation of this method is characterized by the fact that it includes an angle sensor for the steering wheel and an angle sensor at the site of the lower part of the steering column as well as a device for computation from the measured angles of the set point of the assistance torque to be applied by the motor to the steering column.

According to one characteristic of the invention, the invention includes an angle sensor arranged at the site of the upper part of the steering column carrying the steering wheel.

According to another characteristic of the invention, the angle sensor associated with the lower part of the steering column is integrated into the assistance motor.

According to yet another characteristic of the invention, the steering column has a torque rod between the two sites of the column where the angle measurements take place.

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According to yet another characteristic of the invention, the torque rod is an integral part of the steering column.

According to yet another characteristic of the invention, the rod is produced in the form of a controlled torsion part of the steering column.

5   According to yet another characteristic of the invention, the structure of the steering column itself is realized in the form of a torque rod.

The invention will be better understood and other objectives, characteristics, details and advantages of it will appear more clearly in the following explanatory description with reference to the appended diagrammatic drawings, given only as examples illustrating an

10   embodiment of the invention, and in which:

- Figure 1 is an oblique view of a motor vehicle electrical power steering system;
- Figure 2 is a view in axial section of the part of the steering column, indicated as A in Figure 1, of an electrical power steering system according to the prior art, and
- Figure 3 is a view of part A of an electrical power steering system according to the

15   invention.

As seen in Figure 1, a motor vehicle electrical power steering (DAE) system essentially includes steering column 1 bearing, at its upper end, steering wheel 2 which can be operated by the driver of the vehicle, mechanical steering device 3 acted on by the lower end of steering column 1, and electric assistance motor 4 with which reducing gear 5 is

20   associated. In a manner known in itself, the mechanical steering device has steering case 5 inside of which a rack, not represented, is axially mobile, and coupling rods 6, 7 on the right side and on the left side, each coupled at one end to the rack and at the other end to the steering device of a front wheel of the device. The rack is moved axially by a pinion gear, not represented, which is connected rotationally with the lower end of steering column 1.

25   Given that steering wheel 2 is mounted so as to be rotationally connected on the upper end of steering column 1, rotation of this steering wheel, effects the axial movement of coupling rods 7 and 8 by means of steering column 1.

Figure 2 illustrates the portion indicated as A in Figure 1 of steering column 1 of an electrical power steering (DAE) system of the prior art. It is observed that portion A of the

30   steering column includes upper part 10 whose upper end 11 bears steering wheel 2, lower column part 13 whose lower end 14 can be connected to articulated lower portion B of steering column 1 which acts on mechanical steering device 3, and intermediate portion 16 in the form of a torque rod which is rotationally connected at the upper part, at 17, to upper column part 10, and at the lower part, at 18, to lower column part 13.

35   Figure 2 also shows, rotationally connected with lower column part 13, helical pinion gear 20 which cooperates with rod 22 provided with peripheral helical toothing

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complementary to the toothing of pinion gear 20. The two toothings mesh with one another. Shaft 22 is put in rotation by assistance motor 4.

It emerges from these figures that lower part 13 of the steering column is produced in the form of a tubular piece which coaxially surrounds a part of torque rod 16, and that the upper end of the latter is connected at 17 with another tubular piece 24 which engages by its lower part, coaxially, in upper portion 26 of piece 13 forming the lower part of the column, whose upper portion is consequently hollowed in order to receive piece 24.

The power steering system according to the prior art, represented in Figure 2, is based on the use of a torque sensor, indicated as 28, for setting the set point of the torque that assistance motor 4 must apply to steering column 1, that is to say to lower column part 13 by means of shaft 22 and pinion gear 20. It is observed that this torque sensor, as indicated above, has a complex and very bulky structure, with the consequence that the structure of the steering column is also bulky both axially and radially.

The invention aims to remedy these disadvantages, which lie in the complex structure and also in the fact that this structure makes the system difficult to use and to calibrate.

Figure 3 shows portion A of a power steering DAE system according to the invention. Because torque sensor 28 is eliminated, the bulkiness of this system is reduced both axially and radially with respect to the known system of Figure 2. In effect, it has proven possible to do without this complex torque sensor for measuring the steering wheel loads, and an estimation, which could be precise, of the steering wheel torque exerted by the driver is sufficient for effective steering assistance.

According to the invention, a sensor of the angular position of the steering wheel, indicated as 30, and which is associated with upper part 10 of the steering column and is mounted on fixed casing 34 is provided for this purpose. The invention uses a second angle sensor, that is to say a sensor of the angular position of lower column part 13. This angle sensor is situated at the level of assistance motor 4, and could be a sensor incorporated in this motor.

Given that the link between the two metallic components formed by the two parts 10 and 13 of steering column 1 is established by torque rod 16 with known characteristics, it is possible to determine a first approximation of the steering wheel torque by the following formula:

(steering wheel angle – motor angle) x torque rod rigidity = steering wheel torque,

with it being possible, of course, for the motor angle to take into account the reducing gear.

In the formula above, the rigidity of the torque rod is taken into account by

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considering that it is this rod that determines the torque of the steering column between the two angle sensors. Of course, it would also be possible to envisage the torque rod as not existing by itself but as being an integral part of the column, either in the form of a part with controlled torsion, or in the form of the structure itself of the column or the whole part

5   between the two angle sensors.

It is possible to provide a correction for this computation enabling one to make the result more precise while taking into account the play in the reducing gear, which could be a few minutes. For this, it would be possible to take into account the sign of the measurement which could be positive or negative. The precision could be improved by a precise

10   calibration of the angle sensors, from the position of the midpoint of the steering. This calibration could take place regularly when the vehicle is stopped or while moving.

More precisely, a program for setting the set point of the torque that must be applied to the steering column by assistance motor 4 begins with the measurement, using the angle sensors, of the position, speed and acceleration of the steering wheel and of the position,

15   speed and acceleration of assistance motor 4.

After verifying the validity of the acquired magnitudes, a first computation is made using a computer that allows one to obtain the load exerted on the steering wheel by comparison of the angular positions between the two sensors, advantageously with integration of the play of the reducing gear during change of the direction of rotation. Then

20   by means of a second computation, the variation of the steering wheel load is established comparing the speeds of rotation between the two sensors. Then, a PID (proportional, integral, differential) type of filtering is applied to the two measurements made, taking into account the preceding information. The resulting information concerning the torque is then used to compute the assistance that must be provided by motor 4.

25   The invention then provides for the possibility of doing a test as to whether recalibration is possible and necessary. This recalibration test could be done based on the information of passage of the steering wheel through the zero position, on the speed of rotation of the steering wheel and of the motor, which must be less than a predetermined threshold, on the question as to whether there is a degraded mode in progress, and on the

30   possible validation of the data obtained during the operation of measuring the magnitudes.

If the recalibration test gives a negative response, the method returns to the operation of measuring the magnitudes.

If the test gives a positive response, one proceeds with a new computation of the position of the midpoint of the steering, and a recomputation of the value of the play in the

35   motor reducing gear is done if this proves to be necessary. After storage of this information, if necessary in an EEPROM memory, the method returns to the operation of measuring the

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magnitudes.

Of course, various modifications can be made on the DAE system proposed by the invention, with regard to the structure as well as the level of utilization. Thus, in the known power steering systems equipped with a torque sensor and provided with an already existing or added steering wheel angle sensor 30, it would be possible to use the method according to the invention without involvement of the torque sensor, for example, in case of defect in the measurement information of this sensor, as a back-up and replacement solution so that the vehicle can continue its travel.